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# EARTHQUAKE HAZARD MAPPING CAPABILITA



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# REFERENCE BOOK

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A GUIDE TO

ABAG'S

EARTHQUAKE HAZARD MAPPING

CAPABILITY

MARCH 1980

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#### **ACKNOWLEDGEMENTS:**

We would like to thank those many people at USGS and working for cities and counties in the Bay Area who took the time to review the many papers that form the basis for this guide.

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White Buff Goldenrod Green White

graphics: Pat Yoshitsu Merrilee Ollendick

#### INTRODUCTION

#### PURPOSES

Since February 1979, ABAG has been developing a series of computer-based map files showing various basic data maps related to earthquakes and several maps derived from those illustrating various earthquake hazards. The project was started for two reasons:

- o to provide information that could be used by local governments in their seismic safety and safety programs
- o to provide an input to various other planning programs at ABAG.

#### FORMAT

This project, unlike many that result in the publication of a final report, will be continuing and various map files will be expanded or upgraded. Therefore, this guide has been designed as a loose-leaf folder so that pages or sections can be replaced or added as ABAG's earthquake hazard mapping capability changes and expands.

The guide contains this introduction and three main sections:

- o a set of sheets describing each of the basic data map files and a cover sheet for that section
- o a set of sheets describing each of the hazard map files and a cover sheet for them
- o a set of sheets describing several applications for the map files (also with a cover sheet).

The guide has also been designed to include a set of the working papers that have been developed to further describe the assumptions that were made and the data used to develop the hazard maps. A sheet summarizing the Working Papers is at the end of the report.

#### EARTHQUAKE MAPPING AND ABAG'S EARTHQUAKE PREPAREDNESS PROGRAM

ABAG's concerns about earthquake safety grew out of three separate, but related, programs. ABAG served as a liaison with other regional planning agencies and with county and local governments in the San Francisco Bay Region Environment and Resources Planning Study. The study, begun in January 1970, was jointly sponsored by the U.S. Geological Survey and the Department of Housing and Urban Development. ABAG completed a report for this study in February 1976, Quantitative Land Capability Analysis - A Method of Applying Earth Science Informion to Planning and Decision Making. The report describes the use of

benefit-cost analysis in weighing the relatve importance of selected earth science hazards, constraints and resources. The report was published as U.S.G.S. Professional Paper 945 in 1979.

During the same period, ABAG prepared a booklet entitled <u>Hazards</u> Evaluation for Disaster Preparedness Planning summarizing the results of a study on evaluating hazards sponsored by the Defense Civil Preparedness Agency of the Department of Defense, completed in August 1975. The project focused on developing a standard method for evaluating earthquakes and several other natural and man-made sources of disasters.

The findings of these reports, as well as other related information, were given to ABAG's member governments in February, 1976 at a General Assembly entitled "On Shaky Ground". ABAG's General Assembly indicated that a program to help prepare the region for coping with major earthquakes is extremely important. Such a program also has been supported by ABAG's Executive Board, Work Program and Coordination Committee and various other committees.

These desires led to the revision of ABAG's General Plan to include several objectives dealing with improving seismic safety and a series of actions to accomplish these objectives focusing on:

- o incorporating seismic safety concerns into ABAG's plan and project review function
- o supporting or advocating legislation at the State and federal level
- o providing assistance to ABAG's member governments in improving their safety and seismic safety programs

The service activities have led to several recent projects, including:

- o a survey of local regulations related to geologic and hydrologic hazards, constraints and resources
- o a survey of geotechnical study costs
- o a review of earthquake insurance issues
- o an extensive review of earthquake hazards and local government liability

The study of liability also resulted in ABAG's advocacy of State legislation that was passed by the legislature and signed by the Governor in 1979.

This earthquake mapping project is providing strong technical support for the Earthquake Preparedness Program. It is enabling ABAG staff to conduct land capability type analyses not only for all nine Bay Area counties, but also at the fine resolution of one hectare (2-1/2 acres).

These overlaying and modeling capabilities are extremely important not only for creating the hazard maps in the first place, but also for combining earthquake hazard concerns with other physical and social constraints for site evaluation and impacts analyses.

#### EARTHQUAKE MAPPING AND THE BAY AREA SPATIAL INFORMATION SYSTEM (BASIS)

This project is closely tied to ABAG's BASIS program. A major objective of BASIS is to develop a regional geographic data base that can be directly used in local, as well as regional, planning applications. It was developed to tie together the data development and map analysis capabilities that had previously been done by outside agencies using different computers and different resolutions. (The land capability study that used a system at the University of California at Davis was one such application.)

BASIS is structured around an array of grid cells, each representing a land area of one hectare (100 meters square) in the UTM coordinate system. It requires over two million of these cells to cover the nine-county Bay Region. Each cell on the ground corresponds to one unit of computer storage; the unit contains data codes representing the characteristics of that cell. Data can be acquired either by reading a tape or by digitizing a map. BASIS is capable of using data based on other coordinated systems (such as longitude/latitude or LANDSAT reference points) by mathematically transforming these reference systems to a common UTM base. This project greatly increases the data available for each cell. The basic data map files listed in the main body of this guide are a product of direct data acquisition.

Much of the power of BASIS lies in its ability to manipulate the basic data map files. A composite of many data sets can be produced through an overlay or modeling process, and can include distance searches or other calculations. Most of the hazard map files are the product of these processes.

BASIS runs on ABAG's V76 computer system, which can handle data transfer to or from most other computer systems. The computer configuration includes a digitizer for encoding mapped data, an electrostatic plotter for producing computer maps, and terminals for on-line access to the data base. The V76 computer contains 128K words of fast semiconductor memory and special operations for handling mathematical operations of high speeds. Six terminals on-line to the computer are used for data entry and user interaction. Data storage is on one 88M byte disk drive and one nine-track tape drive.

Digitized by the Internet Archive in 2014

#### BASIS DATA MAP FILES

As of March 1980, the earthquake hazard maps are based on six basic data map files described on the following pages:

- o geology
- o faults
- o topography
- o landslides
- o tsunami inundation areas
- o dam failure inundation areas

In addition, a land use file has been created to illustrate some applications.

Each of the following sheets consists of five major sections describing various aspects of the map file on the front. The five sections include:

- o Coverage the area of the region covered (including a map) and the resolution of the data
- o Source the scale and name of the source used (if many sources are used a working paper containing the complete list may be referenced)
- o Major categories on map the categories in the file are listed to the extent practicable
- o Used with other files to produce hazard files on a cross-reference to the hazard map files using this basic data file
- o Limitations and future plans limitations in coverage or accuracy are described, together with future plans to upgrade each file

A 1:1 million scale reproduction of the file appears on the back for illustration only. At this scale, a complete map explanation would be meaningless. Potential users should contact ABAG staff to obtain maps of their area of interest and an explanation for those maps.

There are other basic files in BASIS that have not been improved in conjunction with this earthquake mapping project. These files can be divided into two categories, files depicting the physical environment and those depicting the social environment:

#### PHYSICAL ENVIRONMENT

- o average annual precipitation region-wide
- o vegetation San Mateo County only
- o National Flood Insurance Program maps unincorporated areas and some cities
- o flood-prone areas defined by U.S.G.S. in 1972 region-wide
- o coastline features from U.S.G.S. 7-1/2 minute quadrangles region-wide
- o soil associations (generalized from soils types) region-wide
- o average yield from wells region-wide
- o digital terrain tape elevations region-wide.
- o slope stability (generalized to 25 hectare resolution) region-wide
- o air quality problem areas region-wide
- o water quality problem areas region-wide

#### SOCIAL ENVIRONMENT

- o 1970 census tracts region-wide
- o county boundaries region-wide
- o city sphere-of-influence boundaries region-wide
- o airports, seaports, vacant industrial lands region-wide
- o some transportation data
- o landfill sites and service areas



#### **GEOLOGY**

#### BASIC DATA MAP FILE

COVERAGE: All Bay Area counties with San Mateo County in more detail

#### SOURCE:

**SCALE:** 1:62,500 (for basic geology) and 1:125,000 (for flatlands deposits)

NAME: U.S.G.S. Professional Paper 944--Flatlands deposits of the S.F. Bay Area; Geology Map of San Mateo County by Earl Brabb and Earl Pampeyan of U.S.G.S. (in press); various U.S.G.S. and C.D.M.G. maps of other counties generalized (see Working Paper #2 for more information).



March 1980 Hectare resolution

#### MAJOR CATEGORIES ON MAP:

Holocene stream channels
Holo. alluvium - coarse
Holo. alluvium - fine
Holo. basin deposits
Quaternary colluvium
Holo. beach and sand deps.

Holo. Bay mud
Artificial fill
Pleistocene sand
Pleis. marine terrace

Pleis. alluvium - coarse Pleis. alluvium - fine

Late Pleis. alluvium Early Pleis. alluvium

Colma Formation

Montezuma Hills Formation Quaternary undivided (urban) Franciscan Assemblage (General)

Granitic rocks (General)

Materials of Quat./Tertiary age (General)

Other Tertiary or older materials (General)

#### ADDED FOR SAN MATEO COUNTY:

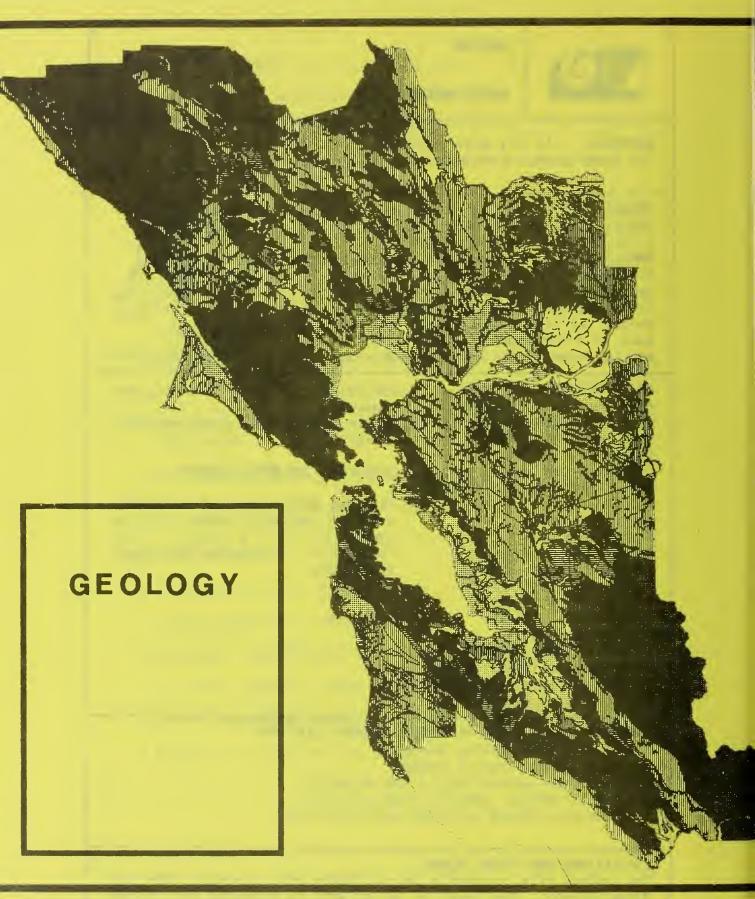
The last four categories are broken into 47 geologic formations and members. For example, the Franciscan is subdivided into seven rock types.

#### USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

- o maximum ground shaking intensity
- o risk of ground shaking damage
- o liquefaction susceptibility and potential
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility

#### LIMITATIONS AND FUTURE PLANS:

The geology file currently is available only in detail for San Mateo County. The level of detail will be increased for fifteen 7-1/2 minute quadrangles of high development potential in 1980 and early 1981. Additional detailed geology will be added for other areas as time and money become available.



BASIS

BAY AREA SPATIAL INFORMATION SYSTEM



#### **FAULTS**

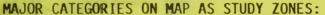
#### BASIC DATA MAP FILE

**COVERAGE:** All Bay Area counties and parts of adjacent counties

SOURCE:

**SCALE:** Largely 1:24,000 with some at 1:60,000, 1:125,000, and 1:250,000

NAME: Special Studies Zones Maps prepared by the State Geologist and additional mapping of fault traces by U.S.G.S. personnel of faults they consider active or probably active. (See Working Paper #1 for a list of sources for the mapping used.)



San Andreas\*
Hayward\*
Crosley\*
Calaveras\*
San Gregorio\*

Maacama Healdsburg\* Rodgers Creek\* Tolay\*

Concord\*
Green Valley\*
Antioch\*
Evergreen\*
Pleasanton\*
Serra

Silver Creek\* Piercy Coyote Creek Sargent\*
Butano
Monte Vista\*
Shannon

Greenville\*
Las Positas\*
Verona\*
Berrocal\*
San Joaquin\*
Midway\*
West Napa\*
Cordelia\*
Dunnigan Hills\*
Faults near Trenton\*
Maacama\*
East of Santa Rosa\*
East of Bennett Valley\*

March 1980

AS FAULT TRACES

Hectare resolution

\*included in intensity mapping (main faults only; no branches)

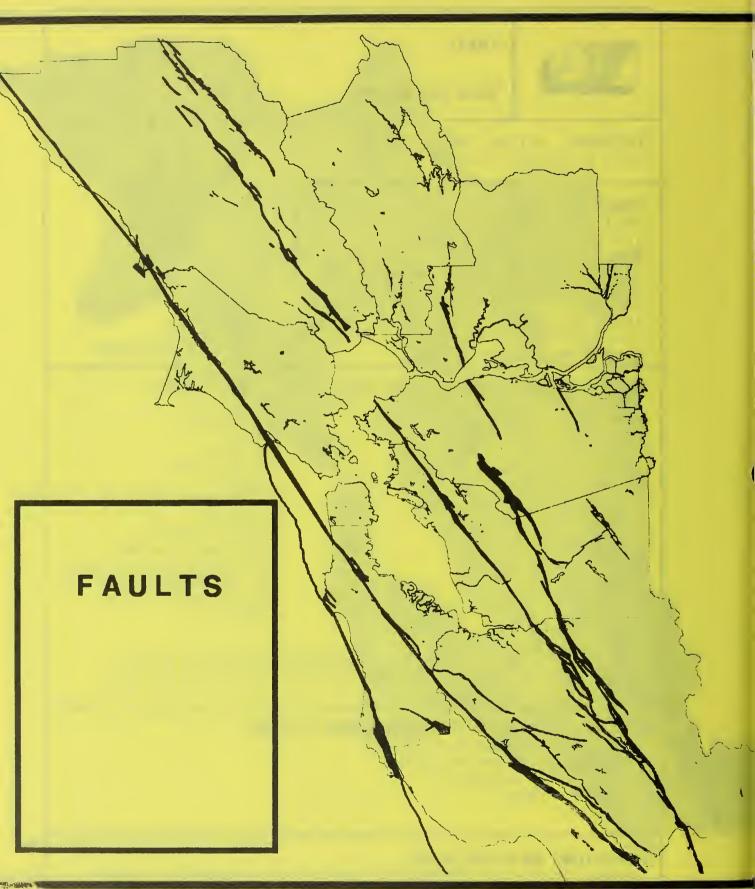
Zayante\*

## USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

- o maximum ground shaking intensity
- o risk of ground shaking damage
- o liquefaction potential
- o surface rupture

#### LIMITATIONS AND FUTURE PLANS:

Changes in Special Studies Zones and in fault traces will be made as new information becomes available. Traces of faults mapped as Study Zones generally are not included. These traces could be added at a future time if a pressing need develops.



BASIS BAY AREA SPATIAL INFORMATION SYSTEM



#### **TOPOGRAPHY**

#### BASIC DATA MAP FILE

COVERAGE: San Mateo County only

SOURCE:

SCALE: Hectare resolution tapes

NAME: Digital terrain model tapes from U.S.G.S. with elevation accuracy of + or

- 5 meters



March 1980 Hectare resolution

#### MAJOR CATEGORIES ON MAP:

Average elevation, in meters, for each hectare

In addition, where the digital elevation model data is available, a program has been run to produce the maximum slope by using the maximum change in elevation between any given cell and the eight surrounding cells (allowing for the longer distance between the cell and those at the four diagonal corners). Other ways of producing slope files could be produced at the request of potential users. The slope file is currently stored as six categories:

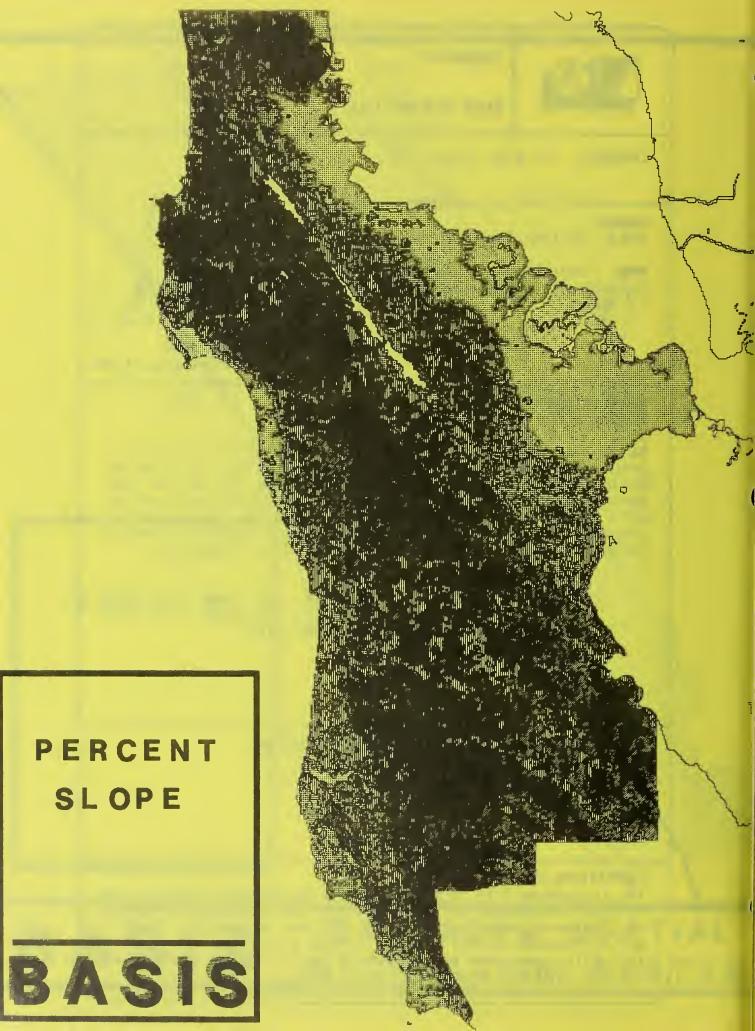
0 - 5% slope 5 - 15% slope 15 - 30% slope 30 - 50% slope 50 - 70% slope 100+% slope

#### USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

o rainfall-induced landslide susceptibility o earthquake-induced landslide susceptibility

#### LIMITATIONS AND FUTURE PLANS:

The topography file is available only for San Mateo County. The file will be expanded to include fifteen 7-1/2 minute quandrangles of high development potential in 1980 and early 1981. The file will be expanded further as money becomes available. When using this file, one should remain aware of the limitations in elevation accuracy (within 5 meters) and spatial accuracy (one hectare).



## LANDSLIDES



#### BASIC DATA MAP FILE

COVERAGE: San Mateo County only

SOURCE:

SCALE: 1:62,500

NAME: Preliminary Map of Landslide Deposits in San Mateo County, CA (1972) by Earl Brabb and Earl Pampeyan of U.S.G.S. (Misc. Field Studies Map MF-344) based on aerial photos with some field checking and some use of local government records and consultants reports.



March 1980 Hectare resolution

#### MAJOR CATEGORIES ON MAP:

Large landslide - definitely present
Large landslide - probably present

Large landslide - of questionable presence

Large landslide - definitely present, of questionable activity Large landslide - probably present, of questionable activity

Large landslide - field checked and definitely active

Small landslide - mapped from aerial photographs

Small landslide - mapped in the field

Small landslide - subsidence of road or ground from public sources

Small landslide - active landslide mapped from public sources

Small landslide - active landslide mapped by private firm

In addition, an area of historic liquefaction (from the 1906 earthquake) in San Mateo County is included on this file based on data supplied by Les Youd of U.S.G.S.

#### USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

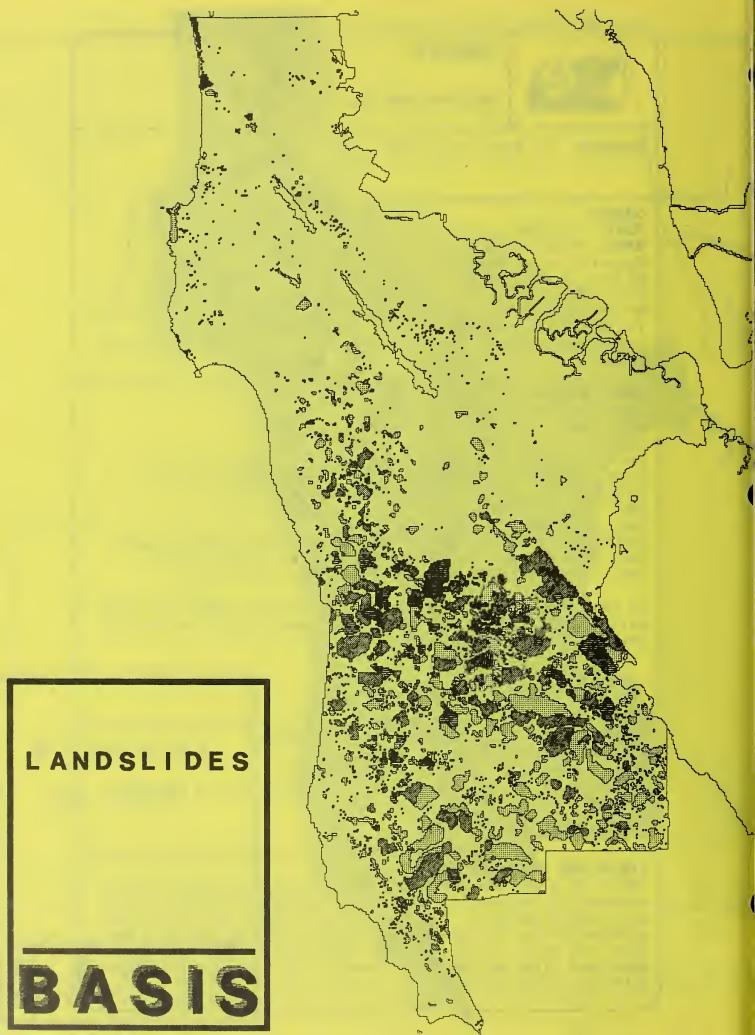
o rainfall-induced landslide susceptibility

o earthquake-induced landslide susceptibility

o liquefaction susceptibility and potential (the area of historic liquefaction)

#### LIMITATIONS AND FUTURE PLANS:

The file is available only for San Mateo County. The file will be expanded to include fifteen 7-1/2 minute quadrangles of high development potential in 1980 and early 1981. The file will be expanded further as time and money become available. The file has been set up to allow for the inclusion of data from local government files and consultants reports. This data, even for San Mateo Co., is out of date.





#### TSUNAMI INUNDATION AREAS

## BASIC DATA MAP FILE.

COVERAGE: All nine Bay Area counties

SOURCE:

**SCALE:** 1:125,500

NAME: Map Showing Areas of Potential Inundation by Tsunamis in the San Francisco Bay Region, CA (1972) by J.R. Ritter and W.R. Dupre of U.S.G.S. (Misc. Field Studies Map MF-480) based on a 500-year event. See Working Paper #6.



#### MAJOR CATEGORIES ON MAP:

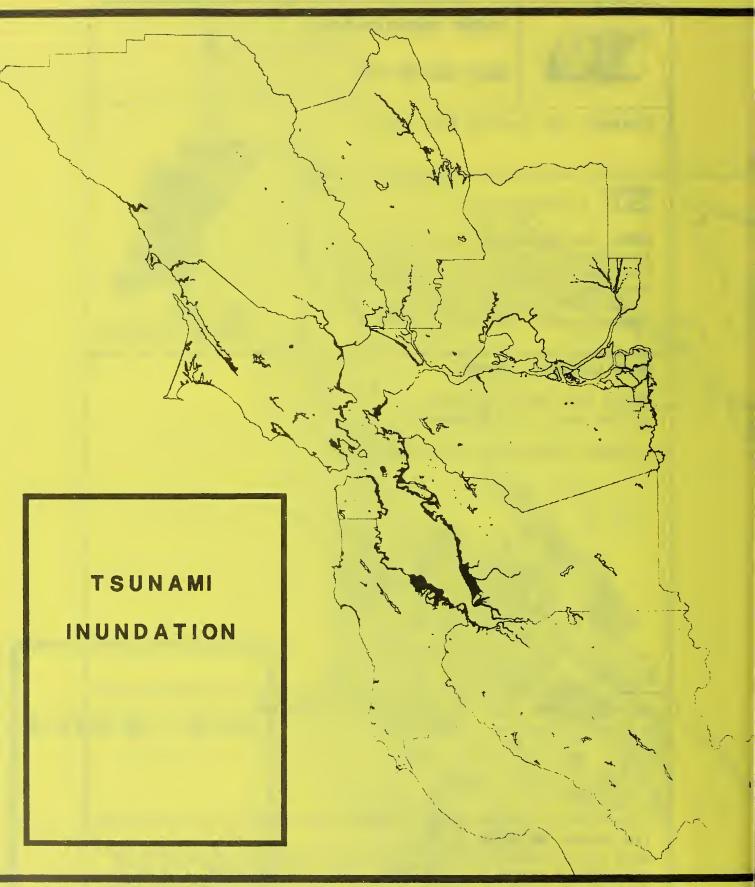
Within areas to be inundated Outside areas to be inundated

(no depth information is provided)

**USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:** o tsunami inundation areas

#### LIMITATIONS AND FUTURE PLANS:

More detailed mapping showing depth of inundation currently is not available in usable form. However, special studies being done in conjunction with the Federal Flood Insurance Program should be available by early 1981. The possibility of replacing this file with more detailed information will be examined at that time.



BASIS

BAY AREA SPATIAL
INFORMATION SYSTEM

#### DAM FAILURE INUNDATION AREAS

#### BASIC DATA MAP FILE

COVERAGE: All nine Bay Area counties

SOURCE:

SCALE: Originals from 1:2,400 to 1:24,000 all redrafted at 1:24,000

NAME: Maps submitted by dam owners to the California Office of Emergency Services to comply with the California Dam Safety Act (Section 8589.5 of the Government Code) for those dams or reservoirs whose total failure would cause injury or loss of life.



March 1980 Hectare resolution

#### MAJOR CATEGORIES ON MAP:

For each of the 134 dams where inundation maps were required: within the inundation area outside of the inundation area (no depth information is provided)

The dams for which maps are provided include:

28 in Alameda County

24 in Contra Costa County

4 in Marin County

16 in Napa County

6 in San Francisco

11 in San Mateo County

28 in Santa Clara County

9 in Solano County

7 in Sonoma County

1 from Mendocino County affecting Sonoma County

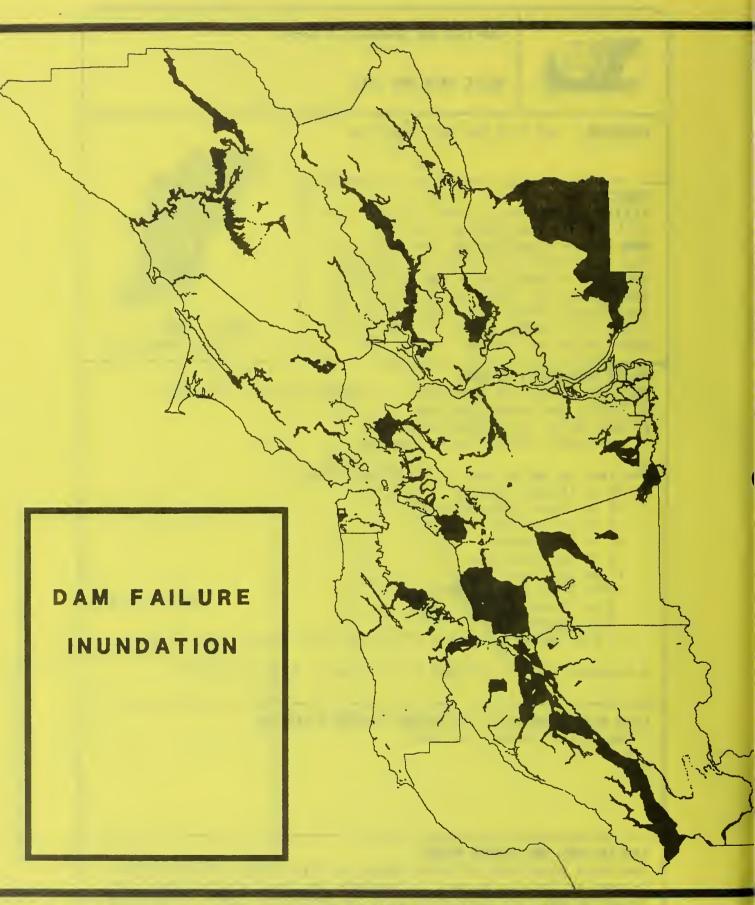
A complete list of the dams is included in Working Paper #7.

#### USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

o dam failure inundation areas

#### LIMITATIONS AND FUTURE PLANS:

The State Department of Water Resources established the criteria to be used by the dam owners to produce the maps and reviewed the completed maps for compliance with the criteria. The file does not contain information on depth of inundation although this information is available from some of the dam owners.



BASIS

BAY AREA SPATIAL INFORMATION SYSTEM



#### LAND USE--1975-1976

#### BASIC DATA MAP FILE

COVERAGE: San Mateo County only

SOURCE:

**SCALE:** 1:24,000

NAME: Land Use and Land Cover Maps prepared by U.S.G.S. showing four levels of land use categories; the maps are published as U.S.G.S. Open File Maps 78-738 to 78-755 and use the classification of Anderson and others of U.S.G.S. described in Prof. Paper 964.



March 1980 Hectare resolution

#### MAJOR CATEGORIES ON MAP:

Urban or Built-up Land Residential

3 sub-categories
Commercial and services
7 sub-categories with
1 further subdivided

Industrial

2 sub-categories Transportation, communication and utilities

6 sub-categories
Commercial and industrial
complexes

Mixed urban or built-up

Other urban or built-up

4 sub-categories with 1 further subdivided

Agricultural Land
Cropland and pasture
2 subcategories with
1 further subdivided
Orchards, groves, vineyards,
nurseries and ornamental

nurseries and ornamental horticulture 3 sub-categories

3 sub-categories Confined feeding operations Other agricultural land

Rangeland
Herbaceous rangeland
Shrub and brush rangeland
2 sub-categories

2 sub-categories Mixed rangeland

Forest Land
Deciduous forest land
Evergreen forest land
3 sub-categories
Mixed forest land

Water
Streams and canals
Lakes
Reservoirs
Bays and estuaries

Wetland Forested wetland Non-forested wetland

Barren Land
Dry salt falts
Beaches
Sandy areas other than
beaches
Bare exposed rock
Strip mines, quarries
and gravel pits
Transitional areas
2 sub-categories
Mixed barren land

# USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

o used only on applications

#### LIMITATIONS AND FUTURE PLANS:

This file is only available for San Mateo County. However, ABAG plans to obtain a file for the entire region of only the first two levels of categories (no sub-categories or further divisions) for the other eight counties in the region by the end of 1980.



#### HAZARD MAP FILES

As of March 1980, the first six basic data maps have been combined to create six hazard map files and three of the basic maps have been converted to three additional hazard files:

- o maximum ground shaking intensity
- o risk of ground shaking damage
- o liquefaction susceptibility
- o liquefaction potential
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility
- o fault surface rupture
- o tsunami hazard areas
- o dam failure hazard areas

Each of the following sheets consists of five major sections describing various aspects of the map files on the front. The five sections include:

- o Coverage the area of the region covered (including a map) and the resolution of the data
- o Source the basic data map files and the key assumptions used
- o Diagram of components a figure depicting the interrelationship of the basic data map files used to create the hazard map files
- o Further information on this file is contained in a list of the working papers further describing the map development and, if applicable, other relevant documents (complete citations are not provided but can be obtained from the working papers)
- o Limitations and future plans limitations in coverage or accuracy are described, together with future plans to upgrade each file

A 1:1 million scale reproduction of the file appears on the back of each sheet. At this scale, an explanation of individual map categories is meaningless. Potential users should contact ABAG staff to obtain maps of their area of interest and an explanation for those maps.



#### MAXIMUM GROUND SHAKING INTENSITY

#### HAZARD MAP FILE

COVERAGE: All Bay Area counties with

San Mateo County in more detail

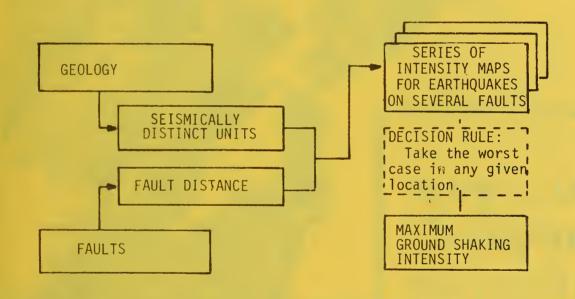
**SOURCE:** The basic data map files on faults and geology are combined to produce this map using data on:

- o maximum magnitude for each fault
- o maximum intensity associated with each
  maximum magnitude
- o the attenuation of intensity with distance from the fault rupture
- o the effect of local geology on intensity



March 1980 Hectare resolution

#### DIAGRAM OF COMPONENTS:

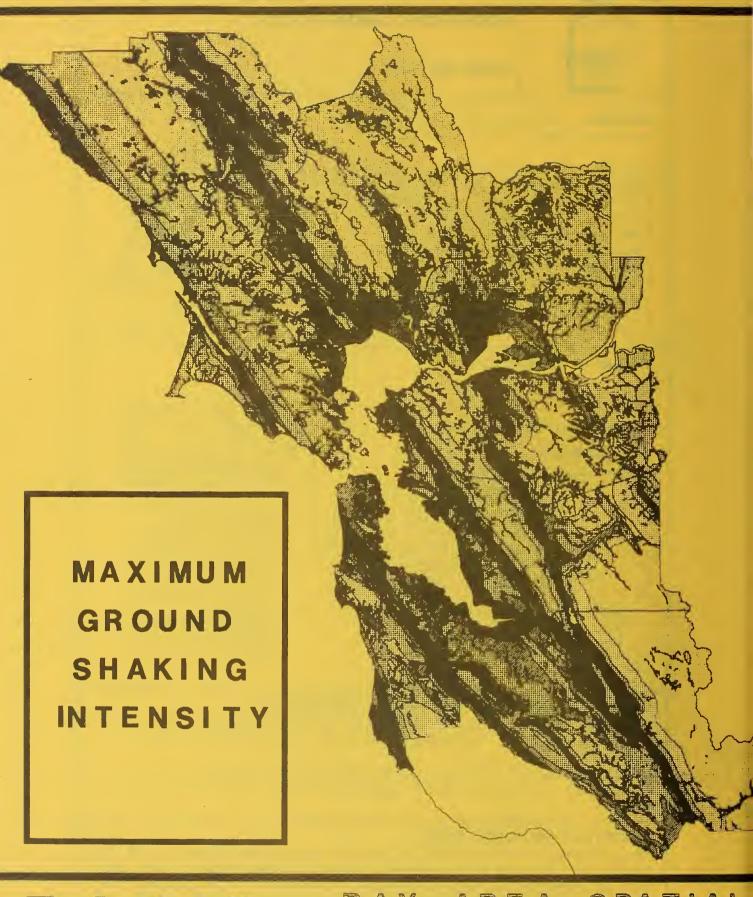


#### FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #1: Faults and Ground Shaking Intensity
- o Working Paper #2: Attenuation, Geologic Materials and Ground Shaking
- o Working Paper #3: Damage and Ground Shaking Intensity
  The method is from U.S.G.S. Profession Paper 941-A (Borcherdt & others)

#### LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between San Mateo County and the rest of the region is fairly insignificant. This file will be recreated as new geology data is entered in the geology file, however. The intensity data is included as San Francisco intensities rather than as modified Mercali intensities. New data on attenuation for modified Mercali intensities would enable the improvement of this file. Data on acceleration may be available by 1982 from U.S.G.S.



BAY AREA SPATIAL INFORMATION SYSTEM



#### RISK OF GROUND SHAKING INTENSITY

#### HAZARD MAP FILE

COVERAGE: All Bay Area counties with

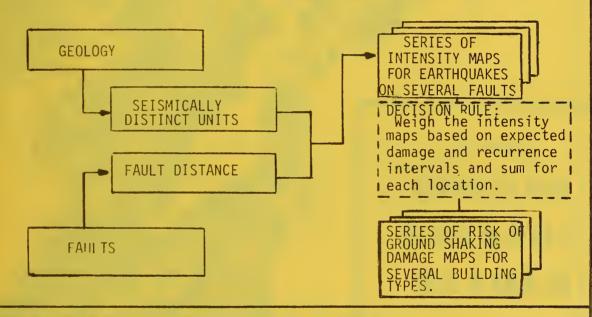
San Mateo County in more detail

**SOURCE:** The basic data map files on faults and geology are combined to produce this map using data on:

- o frequency of different magnitudes of earthquakes on each fault
- o damage associated with intensity
- o the source data used in the maximum ground shaking intensity file



#### DIAGRAM OF COMPONENTS:



## FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #1: Faults and Ground Shaking Intensity
- o Working Paper #2: Attenuation, Geologic Materials and Ground Shaking
- o Working Paper #3: Damage and Ground Shaking Intensity The method is a refinement of a method described in an earlier ABAG publication, Earthquake Intensity and Expected Cost (1978).

#### LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between San Mateo County and the rest of the region is fairly insignificant. This file will be recreated as more geology data becomes available. Better data on recurrence intervals of various magnitudes of earthquakes and on the long term slip rate of faults would greatly improve the reliability of the file. The damage data and resulting risk data are statistical and cannot be applied to any given buildings.

RISK OF GROUND SHAKING DAMAGE CONCRETE **BUIL DINGS** 

BASIS

BAY AREA SPATIAL INFORMATION SYSTEM



#### LIQUEFACTION SUSCEPTIBILITY

#### HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

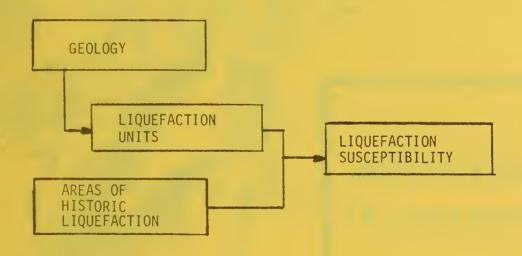
**SOURCE:** The basic data map file on geology was converted to a hazard file based on:

- o type and age of deposit
- o extent of cohesionless materials
- o possibility of cohesionless materials liquefying
- o likelihood of saturation
  (historic liquefaction areas also
  included)



March 1980 Hectare resolution

#### DIAGRAM OF COMPONENTS:



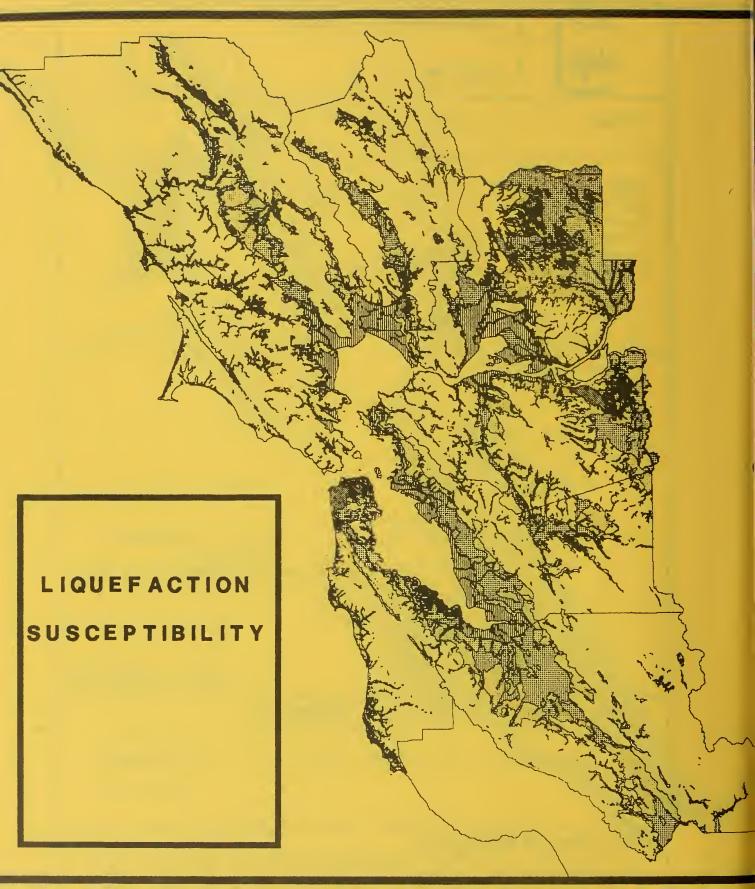
# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #4: Liquefaction Potential Mapping

The method is based on several publications of Les Youd and others of U.S.G.S.

#### LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between San Mateo County and the rest of the region does not affect this file. If a map of ground water table were available for the region, the data on saturation could be improved significantly.



BAS

BAY AREA SPATIAL
INFORMATION SYSTEM



#### LIQUEFACTION POTENTIAL

#### HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

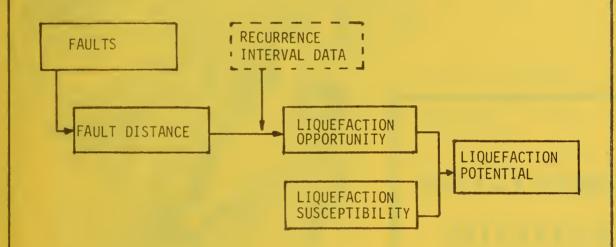
**SOURCE:** The hazard map file on liquefaction susceptibility and the basic data map file on faults are combined to produce this map using data on:

- o the relative susceptibility
- o the liquefaction opportunity (the frequency of earthquakes)
- o a formula relating magnitude to distance from fault for liquefaction



March 1980 Hectare resolution

#### DIAGRAM OF COMPONENTS:



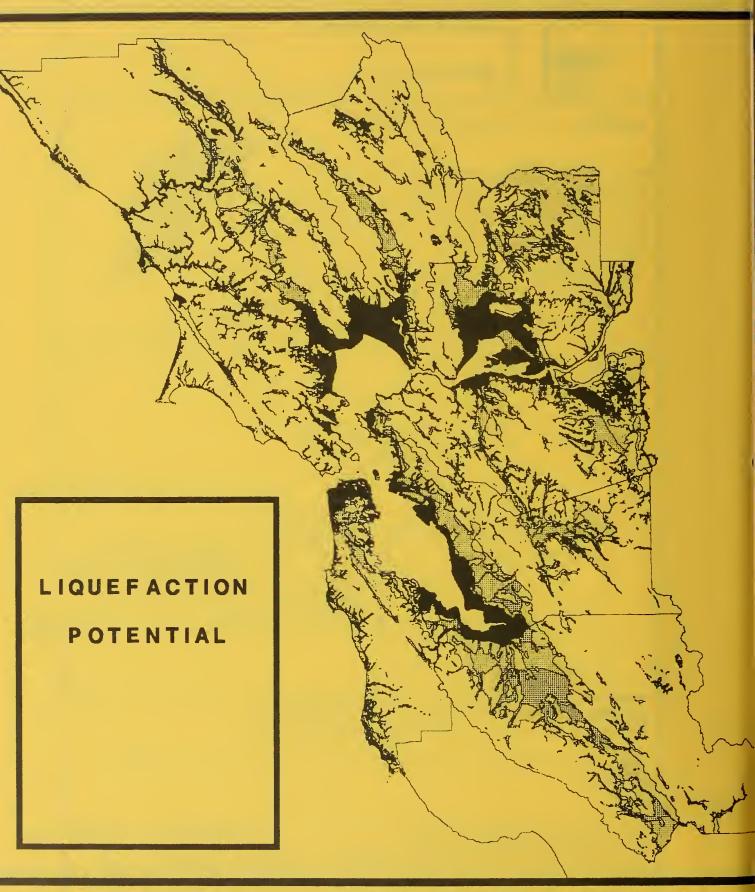
# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #4: Liquefaction Potential Mapping

The method is based on several publications of Les Youd and others of U.S.G.S.

#### LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between San Mateo County and the rest of the region does not affect this file. Any improvements in the liquefaction susceptibility map would obviously improve this hazard map as well. The formula used to relate magnitude to distance from a fault for liquefaction is currently being revised. Better information on earthquake recurrence intervals would improve the reliability of this file.



BAY AREA SPATIAL INFORMATION SYSTEM



#### RAINFALL-INDUCED LANDSLIDE SUSCEPTIBILITY

#### HAZARD MAP FILE

COVERAGE: San Mateo County only

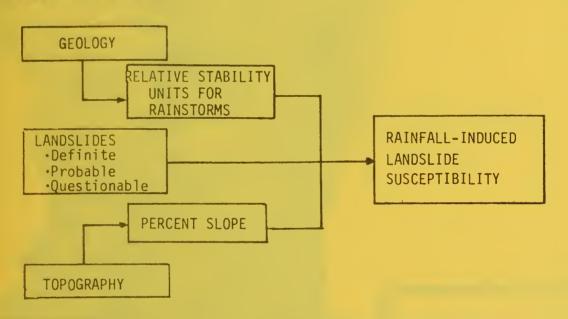
**SOURCE:** The basic data map files on geology, landslides and topography (slope) are combined to produce this map using data on:

- o the surface extent of each geologic unit that has failed by landsliding
- o data on percent slope prior to failure



March 1980 Hectare resolution

#### DIAGRAM OF COMPONENTS:



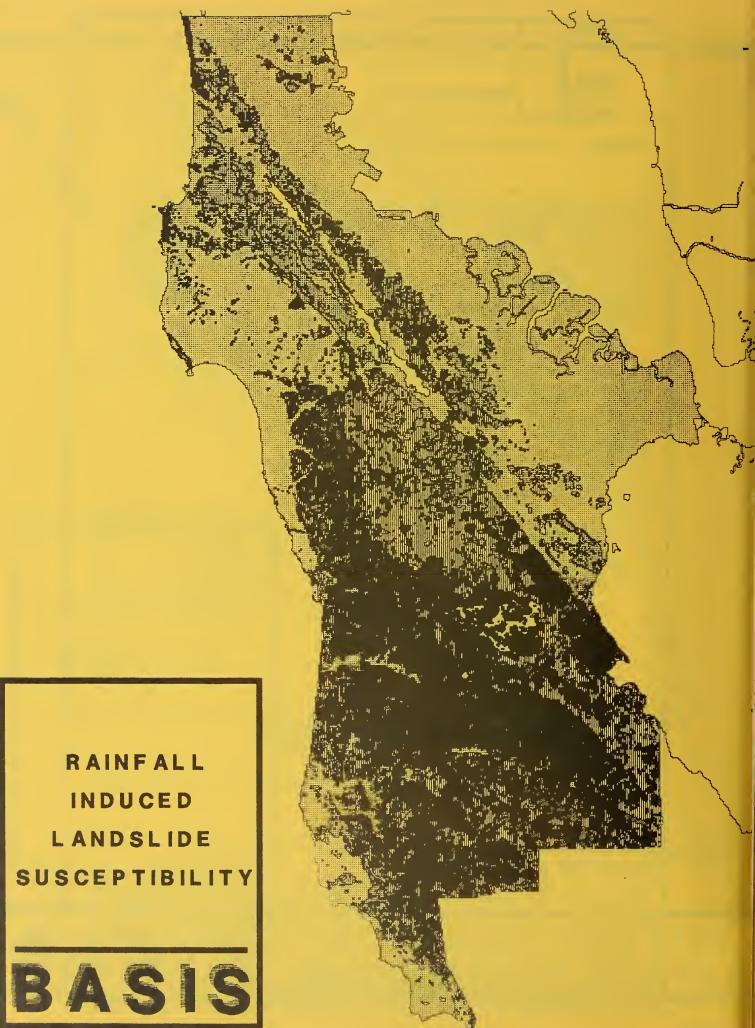
# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #5: Slope Stability Mapping

The method is based on U.S.G.S. Miscellaneous Field Studies Map MF-360 (Brabb and others)

#### LIMITATIONS AND FUTURE PLANS:

This file currently is available only for San Mateo County. The three basic map files used to create this file will be expanded to include fifteen 7-1/2 minute quadrangles in 1980 and early 1981. If the method of combining these files can be applied beyond San Mateo County, this file could be expanded as well. The landslide susceptibility mapping of Nilsen and others (U.S.G.S. Professional Paper 943) is available in BASIS but at 1/4 sq. km. resolution.





# EARTHOUAKE-INDUCED LANDSLIDE SUSCEPTIBILITY

# HAZARD MAP FILE

**COVERAGE:** San Mateo County only

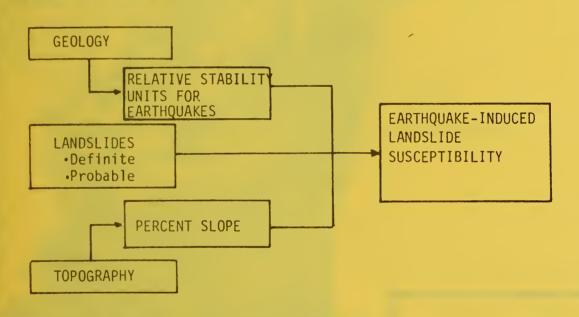
**SOURCE:** The basic data map files on geology, landslides and topography (slope) are combined to produce this map using data on:

- o physical properties of the geologic units (largely relative cohesion)
- o data on historic failures
- o data on saturation characteristics



March 1980 Hectare resolution

# DIAGRAM OF COMPONENTS:



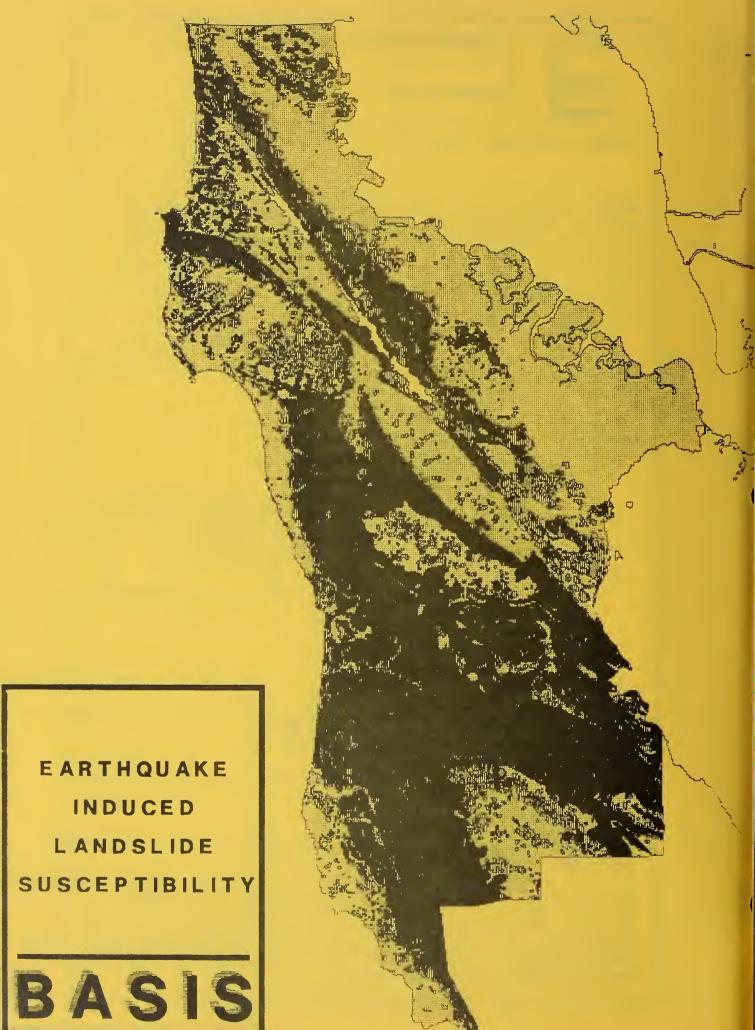
# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #5: Slope Stability Mapping

The method is based on current research of Gerry Wieczorek and others of U.S.G.S.

# LIMITATIONS AND FUTURE PLANS:

This file currently is available only for San Mateo County. The three basic map files used to create this file will be expanded to include fifteen 7-1/2 minute quadrangles in 1980 and early 1981. If the method of combining these files can be applied beyond San Mateo County, this file could be expanded as well. At the present time, insufficient data is available on landslide opportunity to enable a landslide potential map to be created.





# **FAULT SURFACE RUPTURE**

# HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

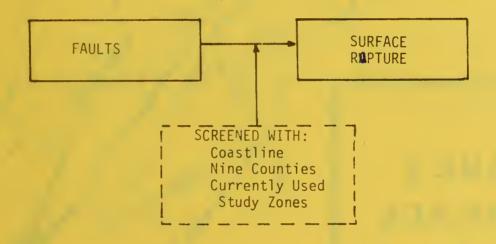
**SOURCE:** The basic data map file on faults is modified using data on:

- o fault activity from U.S.G.S. and C.D.M.G.
- o local government requirements



March 1980 Hectare resolution

# DIAGRAM OF COMPONENTS:



# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

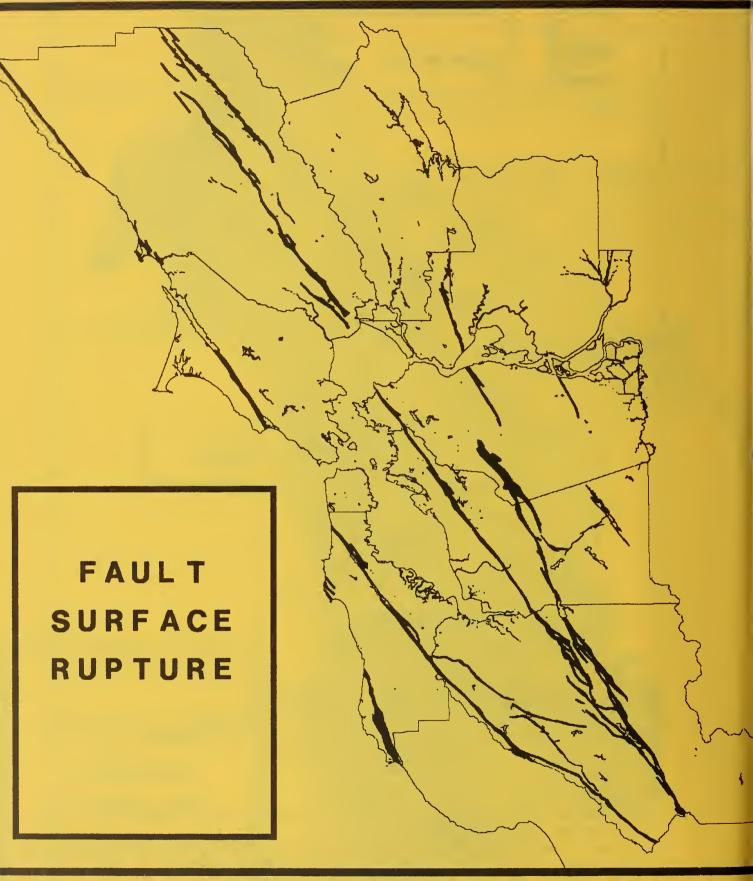
o Working Paper #1: Faults and Ground Shaking Intensity

o Working Paper #9: Earthquake Map Applications for Composite

Earthquake Hazard Mapping

# LIMITATIONS AND FUTURE PLANS:

As new information on fault activity becomes available, both U.S.G.S. and C.D.M.G. staff will modify the maps used as a basis for this file. The hazard file will be modified accordingly.



BASIS BAY AREA SPATIAL INFORMATION SYSTEM



# TSUNAMI HAZARD AREAS

# HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

**SOURCE:** The basic data map file on tsunami inundation areas is currently the map of tsunami hazard areas. This file is included separately to emphasize that the file could have been created with information on topography and runup.



March 1980 Hectare resolution

# DIAGRAM OF COMPONENTS:

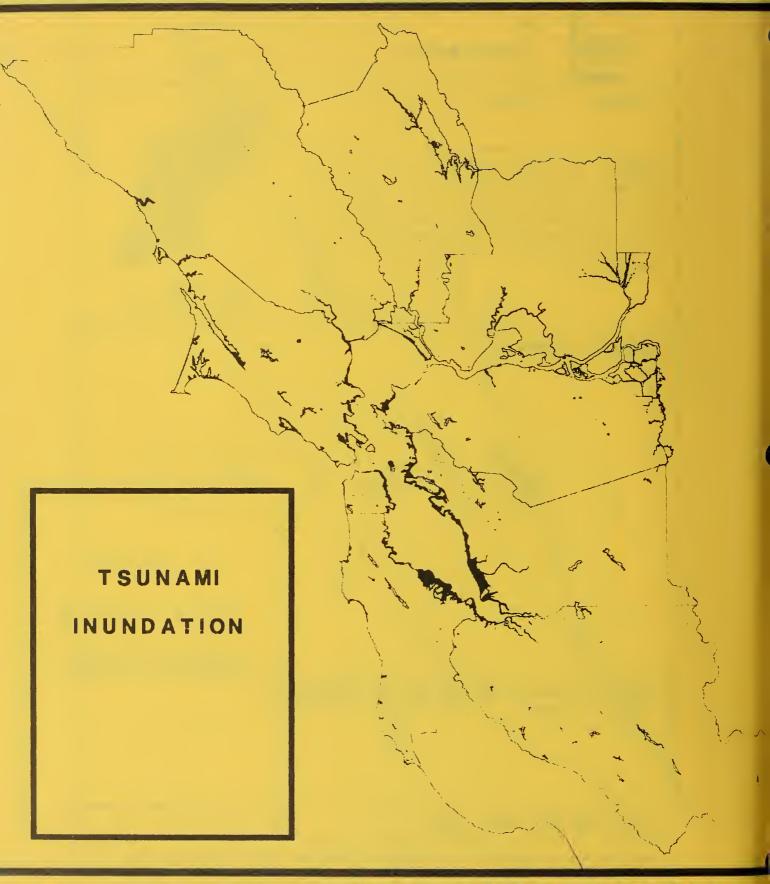
TSUNAMI NO TSUNAMI INUNDATION CHANGE HAZARD

# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #6: Tsunami Inundation Areas

## LIMITATIONS AND FUTURE PLANS:

A more detailed map showing depth of inundation currently is not available in a usable form. However, special studies being done in conjunction with the Federal Flood Insurance Program should be available by early 1981. This file may be replaced with a file that combines data on runup, tsunami, recurrence, and elevation.



BASIS

BAY AREA SPATIAL INFORMATION SYSTEM



# DAM FAILURE HAZARD AREAS

# HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

**SOURCE:** The basic data map file on dam failure inundation areas is currently the map of dam failure hazard areas. This file is included separately to emphasize that the file could have been created with more basic information.



March 1980 Hectare resolution

# DIAGRAM OF COMPONENTS:

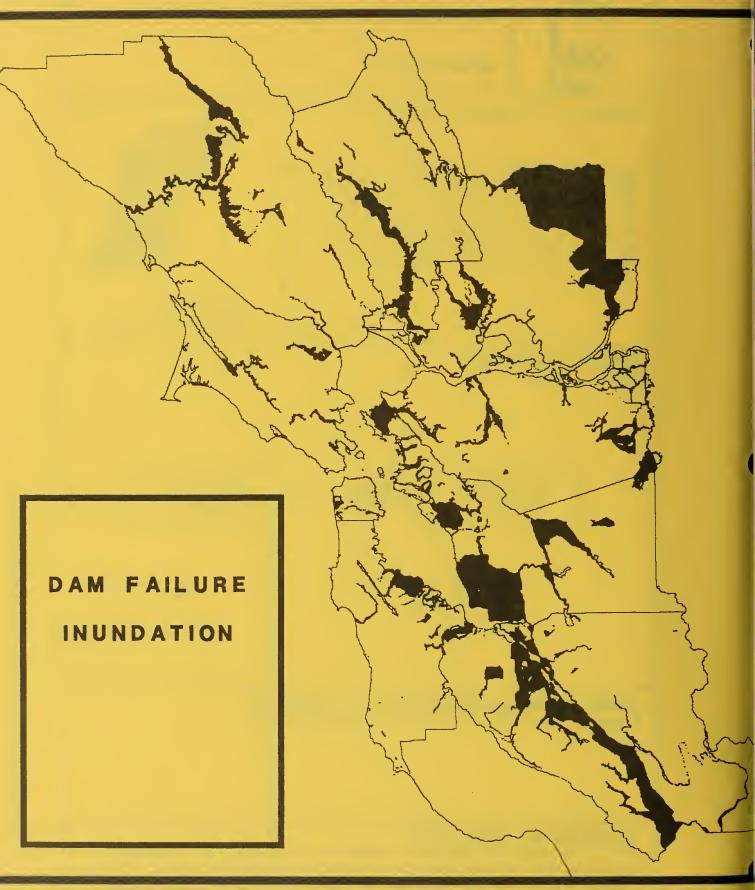
DAM FAILURE NO DAM FAILURE INUNDATION CHANGE HAZARD

# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #7: Dam Failure Inundation Areas

# LIMITATIONS AND FUTURE PLANS:

This file does not contain information on depth of inundation although this information is available from some dam owners. At the present time, little is known on the statistical recurrence of failure of dams, although one would expect that being exposed to earthquakes would increase this rate.



BASIS

BAY AREA SPATIAL INFORMATION SYSTEM

# MAP FILE APPLICATIONS

As of March 1980, these map files can be manipulated for three different types of applications:

- o computer assisted environmental assessment
- o production of composite hazard maps
- o assessment of property and population at risk

Each of the following sheets consists of five major sections describing various aspects of the applications on the front and a sample of an application product on the back. The five sections include:

- o Coverage the area of the region covered (including a map) and the resolution of the data
- o Source files a list of the basic data map files and the hazard map files used
- o Description of product
- o Further information on this file is contained in a list of the working papers further describing the map application
- o Limitations and future plans limitations in coverage or accuracy are described, together with future plans to improve ABAG's ability to produce the products described



# COMPUTER ASSISTED ENVIRONMENTAL ASSESSMENT

# MAP FILE APPLICATION

**COVERAGE:** All nine Bay Area counties with in San Mateo County in more detail

SOURCE FILES: Geology; Faults; Topography; Landslides; Tsunami Inundation Areas; Dam Failure Inundation Areas; Maximum Ground Shaking Intensity; Risk of Ground Shaking Damage; Liquefaction Susceptibility; Liquefaction Potential; Rainfall and Earthquake-Induced Landslide Susceptibility; Fault Surface Rupture



March 1980 Hectare resolution

# DESCRIPTION OF PRODUCT:

This application will produce a background document for development proposals that can be incorporated into the Environmental Impact Report (EIR). This document, as currently envisioned, will have ten parts, each focusing on a different environmental concern. The part dealing with earthquake hazards is "Geology and Soils -- Hazards and Resources". Each section, including the one on geology and soils, contains three parts--setting, impacts, and mitigation. The setting section contains information on five data items: topography, faults, landslides, geologic materials, and soil associations. The impacts section contains information on: rainfall-induced landslide susceptibility, earthquake-induced landslide susceptibility, liquefaction potential, tsunami inundation areas, dam failure inundation areas, maximum earthquake intensities, and earthquake intensity damage and risk. The mitigation section would include those items to be required of the developer by the city or county, including requirements for further study. The information for each section is presented on a single page. A copy of the impacts section for a hypothetical development is reproduced on the back of this sheet.

# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #8: Earthquake Map Applications for Automated Environmental Impact Assessment

# LIMITATIONS AND FUTURE PLANS:

At the present time, because of the limited coverage of the topography, landslide, and landslide susceptibility files, a complete report can be produced only for San Mateo County. The coverage will be expanded to include fifteen 7-1/2 minute quandrangles of high development potential in 1980 and early 1981. The file also could be expanded should a city or county request the service and provide funds for file development.

# GEOLOGY AND SOILS - HAZARDS AND RESOURCES

# IMPACTS

	-	_	т	in chi	Т

SLOPE STABILITY		LIQUEFACTION POTENTIAL				
RAINFALL-INDUCED		AREA (IN HECTAR	ES)			
LANDSLIDE SUSCEPT	TIBILITY	FOM 0				
AREA (IN HECTA	RES)	* 0				
STABLE	61	TO 37				
*	0	* 0				
*	0	* 24				
TO	0	HIGH 0				
*	0					
*	n	DAM FAILURE INUNDAS	TION AREAS			
HNSTABLE	0	DAM	AREA			
		NONE				
EARTHRHAKE-INDUCE	D					
LANDSLIDE SUSCEPT	TRILITY					
ARFA (IN HECTA	RES)					
STABLE	61					
*	0					
*	0	MAXIMUM EARTHQUAKE	INTENSITY			
UNSTABLE	0	AREA (IN HECTARE	ES)			
		A (4) -VERY VIOLENT	0			
TSUNAME THUNDATION A	REAS	3 (3)-VIOLENT	24			
AREA (IN HECTARES		C (2) - VERY STRONG	37			
INSIDE	0	D (1)-STRONG	0			
OUTSIDE	51	F (0)-WEAK	0			
		NEGLIGIBLE	0			

***EARTHQUAKE	INTENSITY		DAMAGE	AMD	RTSK***
---------------	-----------	--	--------	-----	---------

FAHLT	MAXIMUM	RECURRENCE	AVE. INTENSITY
	MAGNITUDE	(IN YEARS)	FOR AVE. ROCK
SAM ANDREAS	8.4(7.2)	1000(100)	Æ
CALAVERAS	7.3(6.7)	300(100)	F
SAN GREGORIO	7.1	200	Ε
HAYKARD	6.9	500	٤
COMCORDIGRN. VAL.	7.0	900	E
HEALDSBURG/ROD. CR.	<b>6.</b> 8	0.05	E
MAACAMA	7.1	500	Ε

\*\*\*INTENSITY INCREASES (OR DECREASES) FOR SEDEUGIC MATERIALS ON SITE\*\*\*
RAY MED 2.9 ARTIFICIAL FILL 1.5

# \*\*\*\*EXPECTED DAMAGE (PER EVENT) AT MARIOUS INTENSITIES FOR \*\*\*\* \*\*\*BUTLDING TYPES PROPOSED FOR SITE\*\*\*

BHILDING TYPES

INTENSITY	
	WOOD-FRAME
1 (4)	16 %
4 (3)	12 %
0 (2)	5 %
0 (1)	۶ ٪
E (O)	0.2%
< F	() Y

# COMPUTER ASSISTED ENVIRONMENTAL ASSESSMENT

# MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties with in San Mateo County in more detail

SOURCE FILES: Geology; Faults; Topography; Landslides; Tsunami Inundation Areas; Dam Failure Inundation Areas; Maximum Ground Shaking Intensity; Risk of Ground Shaking Damage; Liquefaction Susceptibility; Liquefaction Potential; Rainfall and Earthquake-Induced Landslide Susceptibility; Fault Surface Rupture



March 1980 Hectare resolution

# DESCRIPTION OF PRODUCT:

This application will produce a background document for development proposals that can be incorporated into the Environmental Impact Report (EIR). This document, as currently envisioned, will have ten parts, each focusing on a different environmental concern. The part dealing with earthquake hazards is "Geology and Soils -- Hazards and Resources". Each section, including the one on geology and soils, contains three parts--setting, impacts, and mitigation. The setting section contains information on five data items: topography, faults, landslides, geologic materials, and soil associations. The impacts section contains information on: rainfall-induced landslide susceptibility, earthquake-induced landslide susceptibility, liquefaction potential, tsunami inundation areas, dam failure inundation areas, maximum earthquake intensities, and earthquake intensity damage and risk. The mitigation section would include those items to be required of the developer by the city or county, including requirements for further study. The information for each section is presented on a single page. A copy of the impacts section for a hypothetical development is reproduced on the back of this sheet.

# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #8: Earthquake Map Applications for Automated Environmental Impact Assessment

# LIMITATIONS AND FUTURE PLANS:

At the present time, because of the limited coverage of the topography, landslide, and landslide susceptibility files, a complete report can be produced only for San Mateo County. The coverage will be expanded to include fifteen 7-1/2 minute quandrangles of high development potential in 1980 and early 1981. The file also could be expanded should a city or county request the service and provide funds for file development.

# GEOLOGY AND SOILS - HAZARDS AND RESOURCES

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_	_	_	_	_		

SLOPE STABILITY		LIQUEFACTION POTENTIA	L
RAINFALL-INDUCED		AREA (IN HECTARES)	
LANDSLIDE SUSCEP	TIBILITY	LOW 0	
AREA (IN HECT)	ARES)	* 0	
STABLE	61	TO 37	
*	()	* 0	
*	0	* 24	
TO	9	HIGH 0	
*	0		
*	0	DAM FAILURE INUNDATIO	M AREAS
UNSTABLE	n	<b>9 A</b> M	REA
		NONE	
EARTHONAKE-INDUCE	ED		
LANDSLIDE SUSCEPT	TIBILITY		
ARFA (IN HECT)	ARES)		
STABLE	61		
*	ŋ		
*	0	MAXIMUM EARTHQUAKE IN	TENSITY
UNSTABLE	0	AREA (IN HECTARES)	
		A (4)-VERY VIOLENT	0
TSUNANT INUNDATION A	AREAS	3 (3) = VIOLENT	24
AREA (IN HECTARES	8	C (2)-VERY STRONG	37
INSTOE	0	n (1)-STRONG	0
OUTSIDE	51	F (0) -WEAK	0
		NEGLIGIBLE	0
		NEPETPINEE	U

# \*\*\*EARTHQUAKE INTENSITY -- DAMAGE AND RISK\*\*\*

	TO A LOSSON WAY OF THE CO.	or the state of th	10.0
FAILT	MAXIMUM	RECURRENCE	AVE. INTENSITY
	MAGNITUDE	(IN YEARS)	FOR AVE. ROCK
SAM ANDREAS	8.4(7.2)	1000(100)	E
CALAVERAS	7.3(6.7)	300(100)	F
SAM SPEGORIO	7.1	008	Ε
HAYKARD	6.9	200	E
CONCORDIGEN. VAL.	7.0	0.05	E
HEALDSBURG/ROD. CR.	6.8	005	E
MAACAMA	7.1	500	Ε

RAY MIID 2.9 ARTIFICIAL FILL 1.5

# \*\*\*\*FXPECTED DAMAGE (PER EVENT) AT MARIOUS INTENSITIES FOR \*\*\*\* \*\*\*\*BUTIDING TYPES PROPOSED FOR SITE\*\*\*

BUILDING TYPES

TNI	TENSTIY		
		WOOD-FRA	ME
٨	(4)	16	*
-3	(3)	12	¥.
0	(2)	5	%
- ō	(1)	۷	Y.
E	(0)	0.2	%
	eF	n o	Y



# COMPOSITE HAZARD MAPS

# MAP FILE APPLICATION

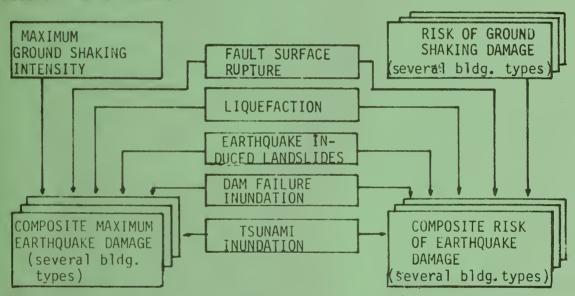
COVERAGE: All nine Bay Area counties with San Mateo County in more detail

SOURCE FILES: Maximum Ground Shaking Intensity; Risk of Ground Shaking Damage; Fault Surface Rupture; Liquefaction Susceptibility and Potential; Earthquake-Induced Landslide Susceptibility (and Potential when available); Tsunami Hazard Areas; and Dam Failure Hazard Areas



March 1980 Hectare resolution

# DESCRIPTION OF PRODUCT:



An example of a composite map appears on the reverse of this sheet.

# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #9: Earthquake Map Applications for Composite Earthquake Hazard Mapping

# LIMITATIONS AND FUTURE PLANS:

Any composite maps that are produced at this time have two limitations. First, the landslide susceptibility file is only available for San Mateo County. Second, the lack of information on landslide opportunity in earthquakes makes the production of a landslide potential map impractical. The current data on damage associated with both landslides and liquefaction make composite maps hypothetical at best.



# ASSESSMENT OF PROPERTY AND POPULATION AT RISK

# MAP FILE APPLICATION

**COVERAGE:** All nine Bay Area counties with San Mateo County in more detail

**SOURCE FILES:** This application can use any of the basic data map files or hazard map files together with the land use jurisdiction and census tract files.



March 1980 Hectare resolution

# DESCRIPTION OF PRODUCT:

This application can produce tables of the amount of land in each hazard category on each hazard map file by:

- o Census tract
- o City sphere of influence
- o County
- o Land Use

An example of these types of tables is reproduced on the back of this sheet. Census tract data could be disaggregated by using the land use data to produce statistics on population at risk. This application will be investigated during 1980.

# FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #10: Earthquake Map Applications for Automated Assessment of Property and Population at Risk

# LIMITATIONS AND FUTURE PLANS:

At the present time, the land use file is available only for San Mateo County so some of the more sophisticated applications only can be performed for that area. In addition, the extent of coverage of the data files may limit those areas where tables can be produced.

# AREA (IN HECTARES) FOR CATEGORIES OF MAXIMUM GROUND SHAKING INTENSITY BY JURISDICTION

# SAN FRANCISCO INTENSITY SCALE

	SHIL LUMINOTORO THIENSTILL SOUTE					
JURISDIÇTION	<u>∢E</u>	<u>E</u>	<u>D</u>	<u>c</u>	<u>B</u>	A
Cities						
ATHERTON	0.	0.	573.	711.	10.	0.
BELMONT	0.	129.	785.	283.	21.	9.
BRISBANE	0.	130.	7.	427.	0.	0.
BURLINGAME	0.	0.	123.	342.	638.	114.
COLMA	0 .	0.	6.	389.	86.	0.
DALY CITY	0.	161.	54.	677.	746.	572.
FOSTER CITY	0.	0.	0.	921.	72.	6.
HALF MOON BAY	871.	802.	1531.	5055	548.	0.
HILLSBOROUGH	0.	0.	866.	675.	122.	19.
MENLO PARK	0.	4.	806.	1494.	698.	0.
MILLBRAE	0.	0.	0.	58.	579.	208.
PACIFICA	0.	686.	1078.	804.	525.	331.
PORTOLA VALLEY	0.	4.	244.	1120.	831.	1108.
REDWOOD CITY	0.	16.	1077.	3137.	1606.	43.
SAN BRUNO	0.	0.	8.	267.	543.	708.
SAN CARLOS	0.	95.	1061.	581.	20.	3.
SAN MATEO	0.	21.	1060.	2203.	263.	10.
SOUTH SAN FRANCISCO	0.	122.	157.	1155.	752.	307.
WOODSIDE	0.	0.	1060.	_		1249.
	•					
Counties ALAMEDA	39296.	50523.	42469.	25213.	33543.	0.
CONTRA COSTA	54370.	69843.	33027.	13644.	16528.	0.
MARIN	8125.	57824.	40531.	14608.	9295.	4383.
NAPA	141612.	33736.	10281.	9430.	388.	0.
SAN FRANCISCO	21.	1216.	1090	7643.	2091.	0.
SAN MATEO	1308.	21422.	36739.	35531	18267.	6356.
SANTA CLARA		44197.			37206.	4340.
SOLANO	72112.	93703.	16815.	-	11245.	0.
		147883.			-	6005.
SONOMA	743176	1410030	00234	30034.	33104.	
Regional						
Total						
DAY ADEA	511970.	520347	<b>356525</b>	223806.	163667.	21084

BAY AREA 511970. 520347. 356525. 223806. 163667. 21084.

# WORKING PAPERS

The working papers referenced in this guide are not automatically included in this document. They can be ordered from ABAG's offices at a charge of \$1.00 for the first copy and \$1.00 for each additional copy or different working paper. This user's guide, complete with all Working Papers, has automatically been forwarded to the planning director in each city and county in the Bay Area.

The available working papers include:

- #1 Faults and Ground Shaking Intensity -- a description of those faults from which significant ground shaking could originate, including source of mapping, length, character of motion, maximum magnitude, maximum intensity, relative slip rate and recurrence intervals for various earthquakes
- #2 Attenuation, Geologic Materials and Ground Shaking -- a description of an attenuation relationship between intensity and distance from faults for a standard geologic material, a method of combining geologic materials into groups with similar responses to earthquake ground shaking, and intensity increments to be added to the standard intensity for each of the seismically distinct groups of geologic materials
- #3 Damage and Ground Shaking Intensity -- a description of how experience from past earthquakes can be used to estimate the damage different types of buildings would experience when subjected to various intensities of ground shaking; also a description of how damage data, the intensity maps, and recurrence interval information can be used to produced maps of risk of ground shaking damage for various building types
- #4 Liquefaction Potential Mapping -- a description of the likelihood of finding cohesionless sediments within a geologic map unit, the likelihood that those sediments (when saturated) would be susceptible to liquefaction, the likelihood of finding those sediments saturated, and liquefaction opportunity (based on recurrence intervals of earthquakes and the distance from various faults at which liquefaction can occur)
- #5 Slope Stability Mapping -- a description of how slope, geology and existing landslides can be used to estimate landslide susceptibility in an earthquake and under more normal circumstances
- #6 Tsunami Inundation Areas -- a description of the data used to develop a tsunami hazard map and of the relative risk associated with tsunamis

- #7 Dam Inundation Areas -- a description of dam inundation mapping and of the relative risk associated with dam failure
- #8 Earthquake Map Applications for Automated Environmental Impact Assessment -- a description of how hazard map files can be used to produce a background document for development proposals that can be incorporated into an Environmental Impact Report
- #9 Earthquake Map Applications for Composite Earthquake Hazard Mapping -- a description of how the various hazard maps can be combined to yield two types of hazard maps of total earthquake associated damage
- #10 Earthquake Map Applications for Automated Assessment of Property and Population at Risk -- a description of how tables of area in cities, counties, census tracts and land use can be created for each hazard map category, as well as some sample tables with a discussion of the conclusions that can be formed. In addition, the feasibility of disaggregating census tract data on population using land use to create data on population at risk in various hazard categories is discussed.



# ASSOCIATION OF BAY AREA GOVERNMENTS ABAG



